PATENT SPECIFICATION

356,094

Application Date: July 12, 1930. No. 10,913/31.

(Divided out of No. 355,895.)

Complete Left: May 12, 1931.

Complete Accepted: Sept. 3, 1931.

PROVISIONAL SPECIFICATION.

Improvements in Epicyclic Gears.

I, Sir FREDERICK HENRY ROYCE, Baronet, of Nightingale Road, Derby, England, a British Subject, do hereby declare the nature of this invention to be as follows:—

This invention is for improvements in epicyclic gears particularly for mechanically propelled road vehicles.

The principle of this invention is to construct an epicyclic train to give two or more forward speeds and to do that in manner better than has heretofore been done.

According to this invention the epicyclic gear comprises a driving shaft and driven shaft, two or more sun wheels rigidly fixed to one of the shafts, a corresponding number of sets of planets each in mesh with one sun wheel carried in cages independently free for rotation relative to the said shaft means for engaging one cage at one end of the series with the other shaft so as to drive or be driven by the latter in the same or reverse direction a number of annulus wheels corresponding to the number of the sun wheels and the cages, the one furthest from the last mentioned cage being normally free for rotation and the others reckoning always from the last mentioned cage rigid with the cage associated with the next adjacent annulus means for holding the annulus associated with the last mentioned cage against rotation and means operable by the driver for holding at will any one of some or of all of the annulus wheels against rotation.

One form of this invention which is given by way of example is as follows. A driving shaft driven by an internal combustion engine carries four sun wheels rigidly mounted thereon. Permanently in mesh with each of the said sun wheels is a set of planet wheels (preferably three in each set). Each set of planet wheels is carried in a cage. Each cage being mounted free for rotation on the driving shaft on opposite sides of the associated sun wheel. Permanently in mesh with each set of planets is an annulus wheel. Each annulus wheel, other than that nearest to the engine is integral with or fixed to a cylindrical flange on the cage carrying the planets next on the engine side to those planets with which the annulus is in mesh. The annulus wheel nearest the engine is mounted normally free for rotation on the driving shaft or on a drum carried thereby, but is adapted at will to be made rigid for rotation therewith by means of a friction clutch or other device for the same purpose. The cage furthest from the engine (the "driving cage") is carried by a hollow shaft extending away from the engine into which is spigotted on roller bearings both driving and driven shafts. The lowest gear is obtained by holding against rotation the annulus associated with the planets in the driving cage. For this purpose a brake engages a drum on the exterior of the said annulus and when the same has been brought to rest the brake and toothed levers of the type and operation as described in my Patent No. 350,114 may be arranged to engage in teeth on the exterior of the said annulus wheel prepared for the purpose. Such levers may be engaged in manner described in my Patent No. 351,121.

The holding against rotation of the annulus next nearest the engine gives the second or next highest gear for which purpose a similar brake and drum with or without toothed levers is provided.

The epicyclic train next nearest the engine serves only to secure a sufficient difference in gear ratio between the second and third speeds and is therefore not provided with any means of holding the annulus against rotation. The annulus nearest the engine which gives both third and fourth speeds has provided for the former a brake with or without toothed levers to hold it against rotation and for the latter is held rigid with the driven shaft by means of a friction clutch. If the first speed annulus is held the sun wheel will drive the planets and cage associated therewith and transmit the

drive to the driven shaft. If now the second be held and the first be free the axially associated sun wheel will drive the planets associated with such annulus which in turn will carry round the first speed annulus which will drive the driving cage at a faster rate, the third speed annulus and the annulus never held rotating idly in a reverse direction. Similarly the speed will be increased as the third speed annulus is held and further increased if the said annulus is held rigid with the driving shaft. All the brakes and the said clutch may be operated by a power relay or manually.

Dated the 12th day of July, 1930.

CLAREMONT HAYNES & Co.,
Vernon House, Sicilian Avenue,
Bloomsbury Square, W. C.

COMPLETE SPECIFICATION.

Improvements in Epicyclic Gears.

I, Sir FREDERICK HENRY ROYCE, Baronet, of Nightingale Road, Derby, England, a British Subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention is for improvements in epicyclic gears particularly for mechanically propelled road vehicles.

The object of this invention is to construct an epicyclic train to give two or more forward speeds and to do that in manner better than has heretofore been done.

This invention applies to the type of epicyclic gear which comprises a driving shaft and driven shaft, two or more sun wheels rigidly fixed to one of the shafts, a corresponding number of sets of planets each in mesh with one sun wheel carried in cages mounted independently free for rotation relative to the said shaft means for engaging one cage at one end of the series with the other shaft so as to drive or be driven by the latter a number of annulus wheels corresponding to the number of the sun wheels and cages, the one furthest from the last mentioned cage being mounted independently free for rotation relative to the shaft which carries the sun wheels and the others reckoning always from the last mentioned cage rigid with the cage associated with the next adjacent annulus and means operable by the driver for holding one annulus wheel at a time against rotation.

Such type of epicyclic gear is hereinafter referred to as the said type.

In the said type of gear different gear ratios are obtained in accordance with which annulus wheel is held against rotation.

When the said type of gear is used in a confined space (such for example as in a road vehicle) it is desirable to keep down the maximum cross section area of the gear box as small as possible, and difficulties may be experienced in obtaining the required gear ratios without having to make one or more of the gear wheels of an inconvenient size or sizes.

The principle of this invention is to overcome this difficulty by providing in the case of one or more of the gear ratios two or more sets of sun wheels planets and annulus wheels only one of which annulus wheels is adapted to be held against rotation.

According to this invention therefore I provide a gear of the said type characterised in that no means are provided for bringing to or holding at rest one or more of the annulus wheels which are accordingly at all times free to rotate.

An example of this invention is illustrated in the accompanying drawing which is diagrammatic and illustrates a vertical section of the gear box which is composed of two castings a and a^1 having sandwiched between them a third member a^2 to form a support and bearing as hereinafter described. The members housed in the casting a^1 form the reverse drive. This invention is not concerned with them. Their operation is fully described in my Application No. 21,167/30 (Serial No. 355,895). b is the driving shaft driven by the engine via a friction clutch (not shown) supported at one end in ball bearings b^1 where it projects through the wall of the casting a and at the other end in roller bearings b^2 where it is spigotted into the sleeve member c hereinafter described, d is the driven shaft also spigotted into the member c on roller bearings d^1. Rigid with the driving shaft b are four sun wheels e, e^1, e^2 and e^3 each permanently in mesh with planet wheels f, f^1, f^2 and f^3 which in turn are permanently in mesh with four annulus wheels g, g^1, g^2, and g^3. The Planet wheels are mounted in cages h, h^1, h^2 and h^3 which in turn are mounted freely

on the driving shaft on ball bearings i. The annulus wheel g has a sleeve like extension j by which it is freely mounted on the driving shaft on ball bearings j^1 and carries at its left hand end dog teeth j^2 for the purpose hereinafter described. The annulus wheel g^1 is integral with the planet cage h, the annulus g^2 with the planet cage h^1 and the annulus g^3 with the planet cage h^2. The planet cage h^3 is integral with the sleeve member c which is supported in ball bearings j^3 where it passes through the member a^2. Friction brakes k, k^2 and k^3 are adapted to bring to and hold at rest the annulus wheels g, g^2 and g^3 while the last mentioned annulus wheel is also provided with external dog teeth k^4 which are adapted to be engaged by tooth carrying levers (not shown) automatically, when the annulus attempts to reverse in manner described in my Patent No. 351,121. At the left hand end of the driving shaft is a sleeve member k^5 carried rigid for rotation, but axially slidable on splines k^6 on the driving shaft and having a dog clutch k^7 adapted to engage the teeth j^2. Displacement of the sleeve k^5 is effected by a fork k^8 engaging in a groove k^9 and operable by the driver in manner not shown.

Turning now to the other end of the gear box the casing a^1 contains the members now to be described for securing a reverse drive. The method of obtaining a reverse drive forms no part of this invention. l is an annulus wheel rigid with the casing a^1 of the gear box. Splined upon the exterior of the sleeve member c and axially slideable thereon is a sun wheel m which is permanently in mesh with planet wheels m^1 carried in cages m^2 freely mounted on extensions of the sun wheel in ball bearings m^3. The planet wheels m^1 are permanently in mesh with an annulus wheel m^4 which is rigid with the driven shaft d both of which are supported in bearings m^5 where the driven shaft passes through the end wall of the casing a^1. The sleeve member c is also supported on the inside of the annulus wheel m^4 by means of ball bearings m^6 and annulus wheel m^4 has formed on the interior of its smaller diameter part teeth m^7. On the exterior of the planet cage m^2 are formed teeth m^8 adapted to engage on the teeth on the member l. The sun wheel m is axially extended in both directions having on its right hand end teeth n adapted on axial displacement to engage with the teeth m^7 and at its other end a groove n^1 into which fits a forked member n^2 which passes through a gap n^3 at the top of the casing a^1 and is formed rigid with a rod n^4 which is operable by the driver in manner not shown.

The way the apparatus works is as follows:—

In the position of the parts as illustrated the apparatus is in neutral. No drive will be transmitted from the driving shaft to the driven shaft. To obtain the lowest gear the driver brings to rest the annulus g^3 by means of the brake k^3 so causing the tooth levers to engage in the teeth k^4 and at the same time by means of the forked member m^2 slides the sun wheel m and the associated planets m^1 in their cage to the right so that the teeth n engage the teeth n^7. The drive will then be transmitted from the driving shaft b to sun wheel e^3, the planets f^3, the cage h^3, the teetb n and n^7 and to the driven shaft d. The annulus wheels g, g^1 and g^2 will during this drive rotate idly in the reverse direction. To increase the speed the brake k^3 is released from the exterior of the annulus g^3 and the brake k^2 is applied to the annulus wheel g^2 causing the latter to stop the brake k^3 being at the same time released. The drive will then be transmitted via the sun wheel e^3 to the planets f^2 which will be carried round the annulus wheel f^2 taking with them their cage h^2. This will carry round the annulus wheel g^3 imparting a faster speed to the planet wheels f^3 and their cage h^3 thus driving the member c and therefore the driven shaft at a higher speed.

To obtain a still higher speed the brake k^2 is released and the brake k applied to the annulus wheel g. This will cause the three annulus wheels g^1, g^2 and g^3 to be carried forward round at increasing speed, thus driving the member c and the driving shaft at a faster speed.

It will be seen that no braking mechanism is provided for the annulus wheel g^1 which serves only to obtain a suitable ratio for the third forward speed when the annulus wheel g is held. To obtain a yet higher speed (direct) the teeth k^7 are engaged with the teeth j^2 by actual movement of the sleeve k^5, the annulus g being released at the same time by the brake k, when this annulus will be driven forward and the whole gear will rotate as a unit.

Instead of the dog clutch formed by the teeth k^7 and j^2 I might provide a non-positive friction clutch or I might incorporate in the said dog teeth clutch a Salerni coupling or other device for facilitating easy engagement. All the brakes and other moving parts may be operated by one or more power relays or manually or some may be operated in one manner and some in the other.

In addition to the brakes k and k^2 the annulus wheels g and g^2 might be held when at rest by positive means, preferably

balanced toothed levers as described in my Patent No: 350,114.

The object of the unbraked annulus in the illustrated example is to secure a sufficiently high ratio for the third speed without constructional disadvantages.

For example it has been found that a convenient set of ratios for a mechanically propelled road vehicle are as follows:—

Top - - -	1 : 1
3rd - - -	1 : .736
2nd - - -	1 : .483
1st - - -	1 : .281
Reverse - -	1 : .283

The sun wheels, planets and annulus wheels of the four trains need not of course be all of the same size, they are only so illustrated for the sake of simplicity and the above ratios may be obtained in a gear according to this invention without difficulty and without making any of the parts of inconvenient sizes by suitably apportioning the sizes of these parts. To obtain such a comparatively high third speed with the other ratios without the use of the extra sun wheel planets and annulus, it would be necessary to increase considerably the third speed sun wheel and annulus and to reduce the size of the associated planets to an extent which would be impracticable or inconvenient. By the use of the extra train however the driven shaft is sufficiently speeded up when the third speed annulus is held to obtain the ratio required.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An epicyclic gear of the type which comprises a driving shaft and a driven shaft two or more sun wheels rigidly fixed to one of the shafts, a corresponding number of sets of planets each in mesh with one sun wheel carried in cages mounted independently free for rotation relative to the said shaft, means for engaging one cage at one end of the series with the other shaft so as to drive or to be driven by the latter a number of annulus wheels corresponding to the number of sun wheels and cages, the one furthest from the last mentioned cage being mounted independently free for rotation relative to the shaft which carries the sun wheels and the others reckoning always from the last mentioned cage rigid with the cage associated with the next adjacent annulus and means operable by the driver for holding one annulus wheel at a time against rotation characterised in that no means are provided for bringing to or holding at rest one or more of the annulus wheels which is or are accordingly at all times free to rotate in either direction.

2. An epicyclic gear as claimed in Claim No. 1 the sun wheels being carried by the driving shaft and with means for obtaining a direct drive by clutching to the driving shaft the said annulus mounted independently free for rotation.

3. An epicycle gear as claimed in Claim No. 2 giving a direct drive and two or more indirect forward gear ratios the higher or highest obtained by holding the said independently freely mounted annulus against rotation and the other or others each by holding the annulus wheels of another epicyclic train against rotation characterised in that an epicyclic train of which the annulus is at all times free to rotate in either direction is incorporated between the said independently mounted annulus (and its train) and the said train or trains associated with said lower indirect gear ratio or ratios.

4. An epicyclic gear as claimed in Claim No. 1 substantially as described with reference to the accompanying diagrammatic drawing.

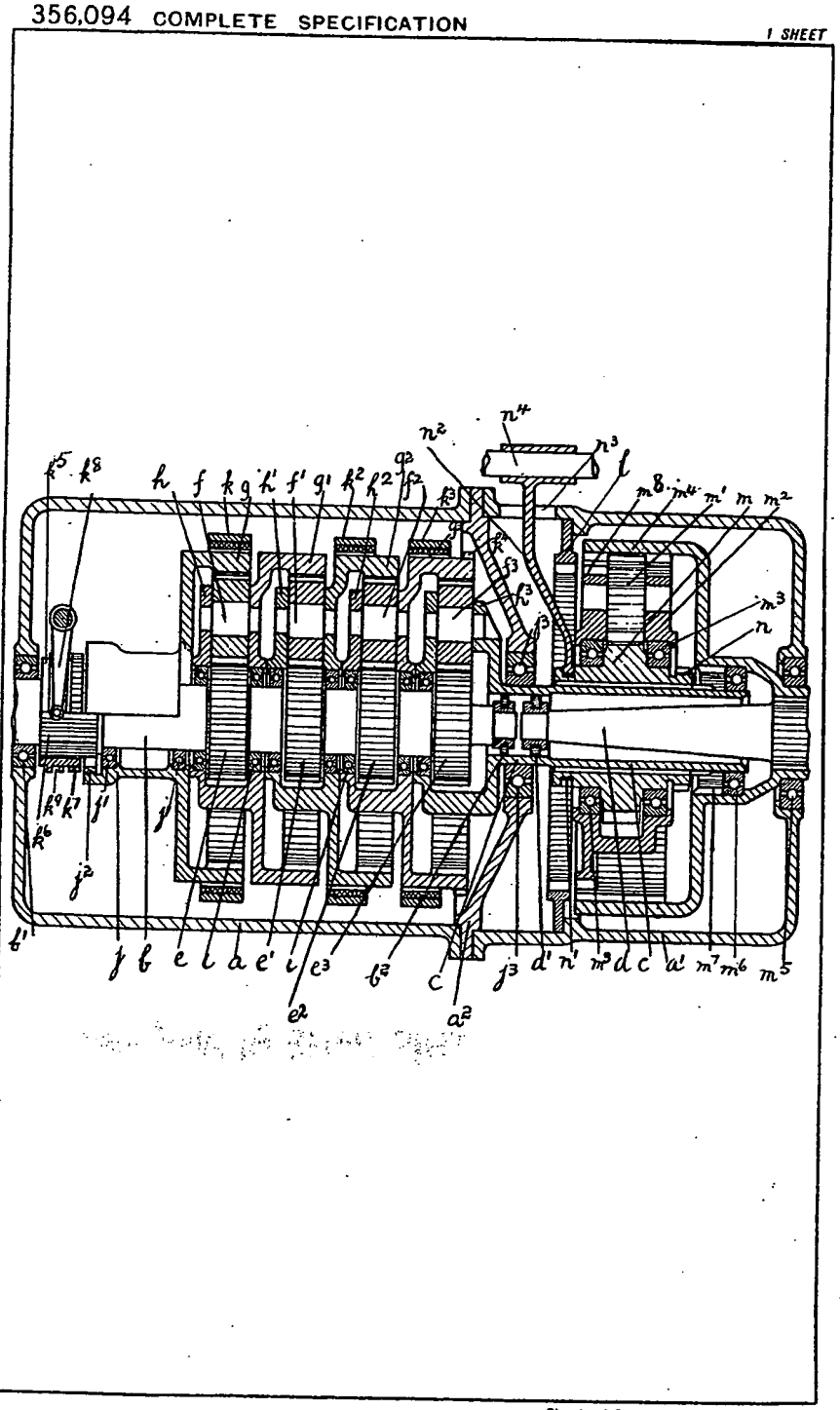
Dated this 13th day of April, 1931.

CLAREMONT HAYNES & Co.,
Vernon House, Sicilian Avenue,
Bloomsbury Square, W.C. 1,
Applicant's Solicitors.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1931.

356,094 COMPLETE SPECIFICATION

1 SHEET



[This Drawing is a reproduction of the Original on a reduced scale]

Charles & Read Ltd. Photo Litho.